February 29, 1872.

FRANCIS GALTON, M.A., Vice-President, in the Chair.

The following communications were read:—

I. "On Putrefaction." By Dr. F. Crace-Calvert, F.R.S.
Received February 22, 1872.

(Abstract.)

This paper is intimately connected with those I have already published on protoplasmic life and the influence it exerts on putrefaction.

I have already shown that when albumen from a new-laid egg is introduced into *pure distilled water* and communication with the atmosphere prevented, protoplasmic life does not appear. If the same solution, however, be exposed to the atmosphere for from fifteen to forty-five minutes, minute globular bodies appear having an independent motion, which I denominate monads. The time required varies according to the time of the year, the amount of moisture present in the atmosphere, and the temperature.

Although M. Pasteur has already noticed the meteorological conditions which influence that life, he has not noticed the extraordinary rapidity with which the fluids are impregnated, and that this impregnation is proportional to the surface exposed.

On the 18th of May, 1871, two portions of albumen, measuring 400 grains, were placed, the one in a test-tube having a diameter of $\frac{3}{4}$ inch, the other in a test-glass which at the surface of the liquid had a diameter of 2 inches. In the tube vibrios appeared after twelve days, whilst in the glass only five days were required for their development. If in place of pure distilled water the water supplied by the Manchester Corporation (which is one of the purest waters in England) was used, the time required for the development of vibrios in a test-tube was only twenty-four hours.

These experiments prove that the rate of development of vibrio-life is influenced by the extent of surface exposed.

M. Pasteur has already demonstrated that oxygen is essential to the life of the Mucedines, but I am not aware that it has been proved that this gas is necessary to the existence of vibrio-life.

In the hope of throwing some light on this subject, the following experiments were made:—

Into each of five glass bulbs equal volumes of a solution of albumen in Manchester water were placed, and the first left in contact with the atmosphere for twenty-four hours, after which the ends of the tube were hermetically sealed about 2 inches on each side of the bulb. After passing oxygen, hydrogen, nitrogen, and carbonic acid over the other four solutions, the tubes were also hermetically sealed. These tubes were kept

closed for twenty-seven days, during which it was observed that the albumen in the bulb containing oxygen speedily became turbid, then the one containing air, while the other three remained clear. After this period the tubes were broken and the contents examined. A large quantity of vibrio-life was found in those containing oxygen and common air, whilst those containing nitrogen, carbonic acid, and hydrogen contained very small quantities, that with hydrogen the least,—thus proving that oxygen is an essential element to the production of putrefactive vibrios.

In further support of this view, I may state that under certain conditions these animalcules produce such an amount of carbonic acid and other gases as to exclude oxygen to such an extent that their own development and life are impaired.

This is easily proved by taking albumen full of animalcules, but not emitting any putrid odour, and placing it in test-tubes, closing some and leaving others open. If these tubes are examined after a few weeks, it will be observed that in those left in the air life has much increased, and they emit a very putrid odour; whilst the life in the closed tubes not only has not increased, but appears to be in a dormant condition; for if the corks are removed and the fluid again comes in contact with the oxygen of the air, its activity returns. The albumen also in the closed tubes does not emit any putrid odour.

M. Pasteur has also found that oxygen was necessary to the vibrios of putrefaction, although the same gas destroyed those produced in butyric fermentation; but he has not made any experiments to show that the products emitted by such vibrios are prejudicial to their development, and even to their power of locomotion.

Having stated above that liquids exposed to the atmosphere become impregnated with monads, I will now try to describe their gradual development into vibrios, and their ultimate transformation into microzyma.

A few hours after the albuminous fluid becomes impregnated, the monads, which have a diameter of about $\frac{1}{128000}$ of an inch, appear to form masses. Then some of the monads become elongated into vibrios, which, though attached to the mass, have an independent motion; so that as the force exerted by the vibrios predominates towards one or another direction, so is the mass moved over the field of the microscope. As the development proceeds, the mass is broken up, and ultimately each vibrio has an independent existence, and may be seen swimming or rolling about in the fluid. Their size at this stage is about $\frac{1}{20000}$ of an inch. These, which I call ordinary vibrios, gradually grow into long vibrios, which attain a length of $\frac{1}{6400}$ of an inch.

These long vibrios gradually become changed into cells, which I have called microzyms. The first process in the transformation is its division into two independent bodies. One extremely faint line appears across the centre of the animalcule, and increases in distinctness until the vibrio appears like two smaller vibrios joined together. The separation takes place

and each part acquires an independent existence. These parts again divide, and the process of subdivision is carried on until they appear to be nothing more than cells, which have a swimming-power so great as to pass over the field of the microscope with rapidity.

After twelve or eighteen months all the vibrios disappear and are replaced by microzyms, either in motion or at rest. If these microzyms are placed in a solution of fresh albumen, vibrios are abundantly developed. The apparent explanation of this fact is that in the fresh albumen they have all the circumstances favourable to their growth and reproduction, while the putrid albumen has become so completely modified as to be incapable of affording them the requisite conditions for reproduction.

I may also notice that at the same time a deposit has taken place which, under the microscope, appears to consist of shoals of small particles of matter which have no life. The solution has now become perfectly clear, possesses considerable refractive power, and has lost the property of becoming coagulated by heat.

The albumen solution does not emit a putrid odour until after the formation of the above-mentioned deposit, and the amount of odour is in direct ratio to the number of vibrios present.

I remarked during the investigation the presence of several other forms of animalcules which contribute to the decomposition and putrefaction of proteine substances, the description of which will be found in the original memoir.

II. "On the Relative Power of Various Substances in preventing Putrefaction and the Development of Protoplasmic and Fungus-Life." By Dr. F. Crace-Calvert, F.R.S. Received February 22, 1872.

(Abstract.)

To carry out this series of experiments, small test-tubes were thoroughly cleansed, and heated to dull redness. Into each was placed 26 grammes of a solution of albumen containing one part of white of egg to four parts of pure distilled water, prepared as described in my paper on protoplasmic life. To this was added one thousandth, or ·026 gramme, of each of the substances the action of which I desired to study.

The reasons why I employed one part in a thousand are two-fold. First, the employment of larger proportions would, in some instances, have coagulated the albumen; secondly, it would have increased the difficulty of observing the relative powers of the most efficacious antiseptics in preventing the development of the germs of putrefaction or decay.

A drop was taken from each of the tubes, and examined under a microscope having a magnifying-power of 800 diameters. This operation was repeated daily with the contents of each tube for thirty-nine days, and from